three cotyledons, when the root is triarch); among cycads the cotyledonary bundles are not of equal value in the production of root structure, and even similarly situated bundles vary in the same species; among the cycads the cotyledonary bundles fuse with the plumular traces and ultimately form a central cylinder of variable structure.

Root.—In Ginkgo there may be an addition of protoxylem elements after the root structure has been organized; in Stangeria the primary root may branch dichotomously; after the initial root structure has been attained, the number of poles may be increased at lower levels.

The paper closes with a very useful table showing the variation in the number of bundles in the base of the cotyledons of the fourteen species discussed, and also the relation of this number to the number of poles in the root structure.—J. M. C.

Adaptation in fossil plants.—In his presidential address[18] at the anniversary meeting (May 24) of the Linnean Society, SCOTT took occasion to outline the evidence for adaptation from fossil plants, which naturally dealt chiefly with the anatomical structures of those ancient vascular plants which he has done so much to elucidate. No one is more competent to state the facts in reference to ancient plants, but the conclusions do not seem to be irresistible. In substance they are as follows: (1) at all known stages in the history of plants there has been a thoroughly efficient degree of adaptation to the conditions existing at each period; (2) the characters of plants always having been as highly adaptive as they are now, natural selection appears to afford the only key to evolution which we possess at present; (3) the paleontological record reveals only a relatively short section of the whole evolution of plants, during which there has not been any very marked advance in organization, except in cases where the conditions have become more complex, as illustrated by the floral adaptations of angiosperms; (4) the simple forms of the present flora are reduced rather than primitive, but such reduction may have set in often at a relatively early stage of evolution, and is therefore consistent with a considerable degree of antiquity in the reduced forms.

These broad statements, quite apart from their application to certain views of adaptation, contain much wholesome truth for those who imagine that the paleontological record, as we know it, represents a continuous succession of "higher and higher" plants, for it is becoming increasingly evident that very highly organized plants existed at the very beginning of our record.—J. M. C.

Morphology of Penaeaceae.—STEPHENS published a preliminary account[19] of his studies among the Penaeaceae which was noticed in this journal.[20] There has now appeared the full account with illustrations,[21] so that the morphological

[18] SCOTT, D. H., Presidential address before Linn. Soc., 1909. pp. 15.

[19] STEPHENS, E. L., A preliminary note on the embryo sac of certain Penaeaceae. Annals of Botany **22**:329. 1908.

[20] BOT. GAZETTE **45**:365. 1908.

[21] STEPHENS, E. L., The embryo sac and embryo of certain Penaeaceae. Annals of Botany **23**:363–378. *pls. 25, 26.* 1909.

features of this small shrubby group, restricted to the southwestern region of Cape Colony, are fairly before us. Three of the five genera were investigated (Sarcocolla, Penaea, and Brachysiphon), suitable material of the other two (Endonema and Glischrocolla) not being available.

The morphological characters of the three genera examined are the same, so that one account can serve for all. The megaspore mother cell produces four nuclei, usually tetrahedrally arranged, and these migrate to the periphery of the embryo sac, where each gives rise to a group of four nuclei. Three of the nuclei of each group are organized into cells which resemble an egg-apparatus, while the four remaining free nuclei fuse in the center of the sac to form the primary endosperm nucleus, which after fertilization forms a parietal layer of nuclei, walls appearing much later. The embryo has no suspensor, appearing first as a spherical mass of cells, which elongates as the tissues are differentiated and the growing points are organized.

This seems clearly an illustration of the formation of an embryo sac by the cooperation of four megaspores, in this case the product of each megaspore remaining remarkably distinct.—J. M. C.

Embryo sac of Pandanus.—A preliminary note[22] under this title has already been referred to in this journal.[23] The fuller account, with plates, has now been published.[24] Pandanus has long been regarded as a promising primitive monocotyledon, and its investigation is most timely. The general results are as follows: the archesporial cell (presumably solitary) cuts off a parietal cell which gives rise to several layers of cells separating the epidermis from the megaspore mother cell; the mother cell divides transversely into two daughter cells, the inner one of which directly produces the embryo sac, while the outer one divides anticlinally; the first division within the sac (the second reduction division) results in two polar nuclei; the micropylar nucleus divides, and there is no division of the daughter nuclei, nor is there usually any differentiation into egg and synergid; the antipodal nucleus gives rise to twelve nuclei, whether by simultaneous division or not was not determined; in the most advanced stages secured no nuclear fusion was observed, all fourteen nuclei remaining quite separate.

The author still maintains that the embryo sac of Pandanus is a more ancient type than the ordinary eight-nucleate sac of angiosperms, and that it represents a new type, "with its nearest analogue in Peperomia." It remains to investigate the fertilization stages of this interesting embryo sac, to determine whether the fourteen-nucleate condition really is the fertilization stage.—J. M. C.

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[22] CAMPBELL, D. H., The embryo sac of Pandanus. Preliminary note. Annals of Botany **22**:330. 1908.

[23] BOT. GAZETTE **45**:364. 1908.

[24] CAMPBELL, D. H., The embryo sac of Pandanus. Bull. Torr. Bot. Club **36**:205–220. *pls. 16, 17.* 1909.